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Highly trained athletes display increased muscle coordination variability in bench press

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Introduction: The aims of this study were to investigate the muscle coordination associated with bench press to quantify the role of expertise level on muscle synergies and to investigate the impact of four different normalization procedures.

Methods: Eleven male untrained (UNT) subjects and 11 male elite power lifters (EXP) completed four different normalization procedures and 3 submaximal sets of 8 repetitions. Surface electromyography (EMG) was recorded from 9 muscles. Normalization procedures consisted of an isometric maximal voluntary contraction (MVC) for all muscles, an isometric MVC in bench press, a maximal and a submaximal dynamic contraction in bench press. Muscle synergies were extracted from 24 bench press cycles using a decomposition algorithm. The least amount of synergies that provided ≥ 90% of variance accounted for was selected. The activity of the individual muscles was also calculated.

Results: Synergy activation coefficients 1(0.79 vs. 0.65 ($P = 0.016$) and 2 (0.75 vs. 0.30 ($P = 0.001$)) and muscle synergy vectors 2 (0.35 vs. -0.17 ($P = 0.027$)) were more synchronous among UNT than EXP with a higher median correlation coefficient. On contrary, the timing of activity was more synchronous in EXP than in UNT. The maximal dynamic normalization procedure produced the least amount of variability and the most reliable recognition of activation coefficients and synergy vectors.

Conclusions: EXP were characterized by a more variable motor strategies, i.e. synergy activation coefficients, muscle synergy vectors. EXP were capable of benefiting the motor abundancy/redundancy, exploiting the functional constraints of the task at hand, while UNT could not.